Benefits of Vegetated Agricultural Drainage Ditches (VADD) as a Best Management Practice in California

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(Pesticide Reduction and Investigation of Source Mitigation)

Project Participants

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Key Partnership

Phase I - Private Landowner

- Private land, familiarity with field/soils, water source, equipment, construction time, “reality check,” interest in issue

Phase II – Multiple Private Landowners

- All of the above contributions + coordination (inconvenience) between normal management activities and study

Problem

- Storm water runoff from agricultural fields is a significant water quality concern
- Nearly 1400 pesticide TMDL’s exist in US
- In California, pesticides are #2 impairment to state water bodies (behind metals)
- Of pesticide impairments in CA,
  28% are from either chlorpyrifos
  or diazinon

Current Situation:

- Yolo Bypass is a major water source for California's San Francisco Bay Delta
- Diazinon & Chlorpyrifos: 2 most often identified OP insecticides in California water samples
- OP use has recently declined
- Pesticides of choice to replace OPs: Pyrethroids

We need a solution that will…

- Decrease the concentration of pesticides associated with storm and irrigation runoff from farm
- Be relatively easy to implement
- Be cost-effective for farmers and landowners
- Not substitute one problem for another

Possible Solution… Vegetated Drainage Ditches

- Ditches already exist in various forms in agricultural, urban and industrial landscapes
- Adjustments to existing management practices could be minor
- Historically efficient way to move water away from a desired location (or to a location in the case of irrigation needs)

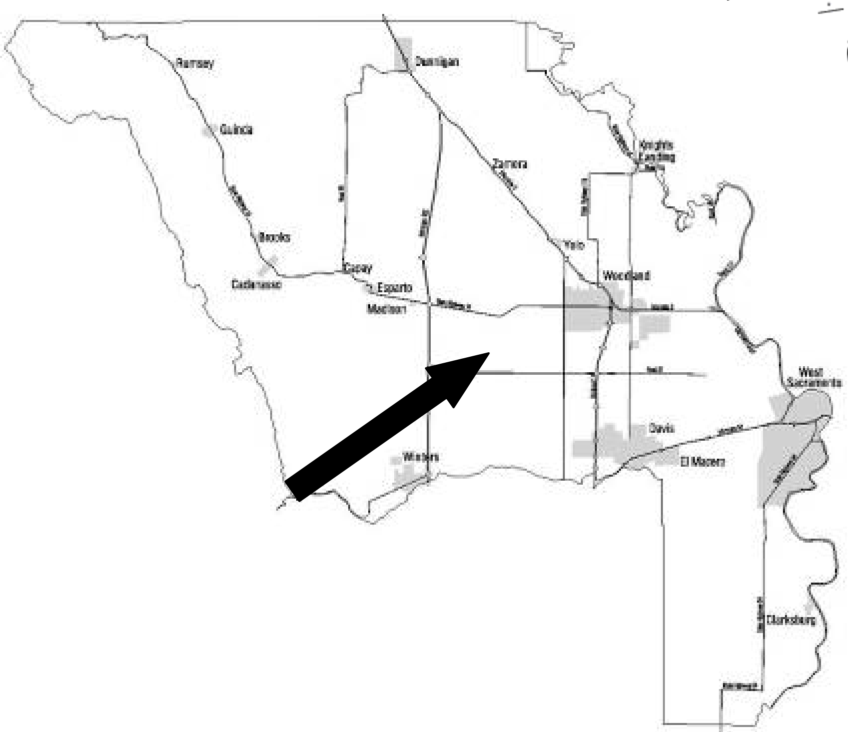
Additional ecological and environmental benefits:

- soil stability
- weed suppression/competition
- Habitat for native insects, reptiles, small mammals

Based on Previous Work

- Moore, M.T., Cooper, C.M., Smith, S. Jr., Bennett, E.R., and Farris, J.L. Drainage ditches: New conceptual BMP's for non-point source pollution and TMDL development. Proceedings of the 7th Federal Interagency Sedimentation Conference, pp. 65-71. 2001.
- Moore, M.T., Bennett, E.R., Cooper, C.M., Smith, S. Jr., Shields, F.D. Jr., Farris, J.L., and Milam, C.D. Transport and fate of atrazine and lambda-cyhalothrin in an agricultural ditch in the Mississippi Delta, USA. Agriculture, Ecosystems and Environment, 87:309-314. 2001.
- Bouldin, J.L., Milam, C.D., Farris, J.L., Moore, M.T., Smith, S. Jr., and Cooper, C.M. Evaluating toxicity of ASANA XL (esfenvalerate) amendments in agricultural ditch mesocosms. Chemosphere. 56(7):677-683. 2004.

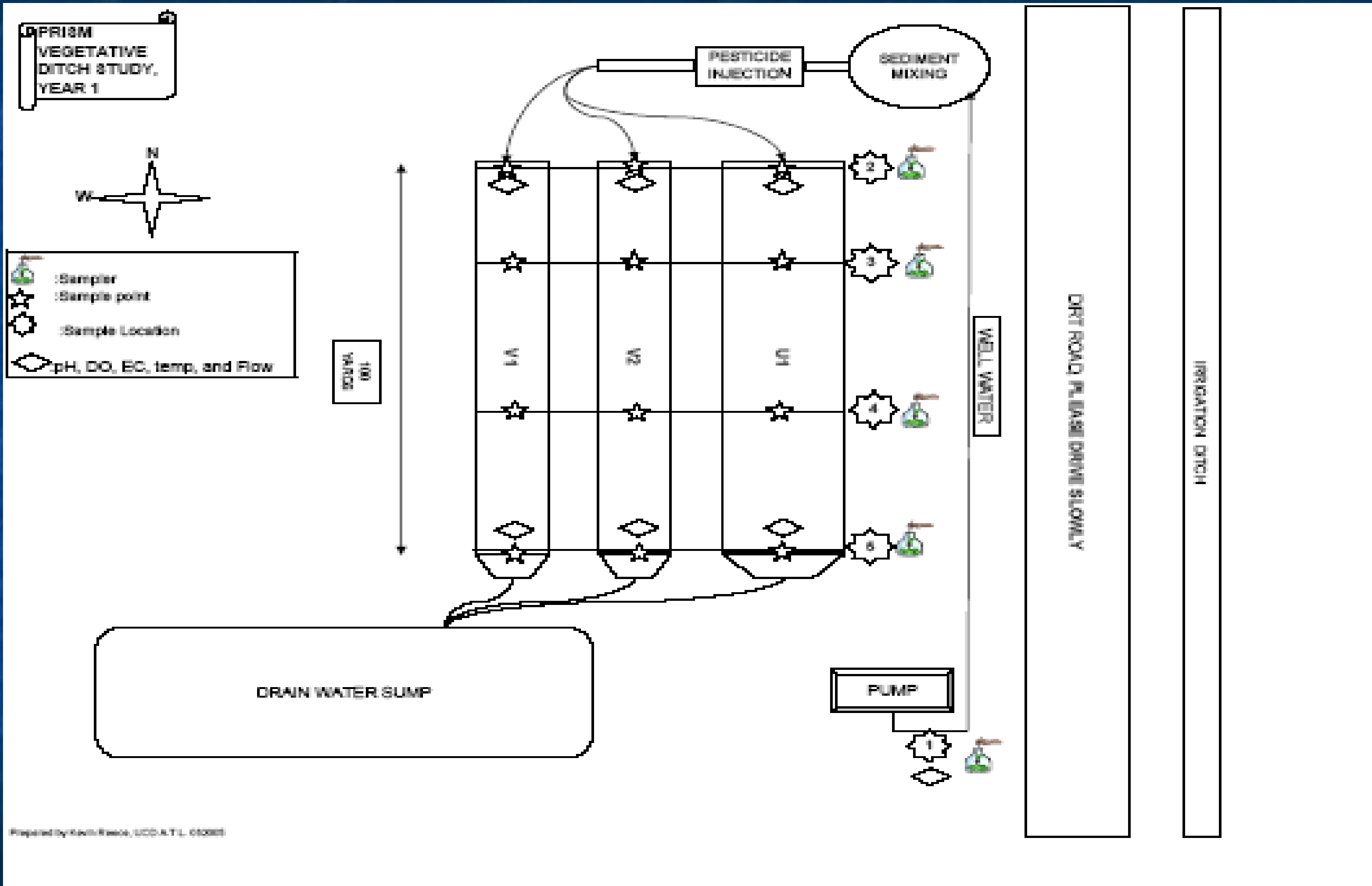
Introduction to the Project



Introduction to Project – Phase I

- 3 constructed ditches:
  - U-shaped (compare to Mississippi)
  - V-shaped/vegetated
  - V-shaped/un-vegetated
- Water Control Structures (flashboard risers)
- Runoff holding pond
- Controlled water delivery system
- Controlled pesticide/sediment delivery system

Field Site Layout




GLASS

Pesticide-related Management Practices –Tomato

- Planted in spring, now usually transplants
- Pre-irrigated to plant into moisture, then sprinkled
- Furrow irrigation ~ ea. 10-14 days through mid-august (depending on soils, slope, weather. . .)
- Approx. 15-20 possible insect pests
- Treatment according to monitored pest levels
- ~65% chance of use of Sulfur
- ~20% chance use of insecticides for a variety of pests.

Pesticide-related Management Practices -Alfalfa

- Planted in fall (rarely spring); 3-5 year crop
- Possible <u>single</u> spring treatment for weevils
- Possible 1-2 treatments/year for Alfalfa caterpillar, late summer, or treatment for armyworm, according to monitoring results
- 10-15 different insect pests that could cause crop injury
- Approximately 7-8+ irrigations/year, alternating with cuttings (~ ea. 28 days)
- Irrigation, cutting and pest management is a dynamic process

Project Objectives

- Investigate/determine efficacy of vegetated ditches for water quality improvement in California agricultural conditions.
- Determine optimal ditch parameters to mitigate organophosphate and pyrethroid insecticides
- Validate (under field conditions) ditches as a management practice for mitigation of diazinon and permethrin runoff

Project Hypotheses

At the end of the ditch, pesticide concentrations will be:

- below the WQ objective or TMDL numeric target level for diazinon / permethrin
- below the toxicological effect level of concern for both water column and sediment test species

Project Framework

Phase 1:

Intensive study in constructed ditches

- Controlled dosing with pesticides and sediment (Pounce 3.2 EC (permethrin), Diazinon AG500)
- Timed sampling (soil, water, plant) at 4 locations in each ditch: hour 0.5, 1, 4, 8, 12, 24, 48, 72, 96
- Monitor water pH, DO, temperature, flow
- Sample analysis (pesticide concentrations in soil, plant, water)

Project Framework

Phase 1, cont'd:

Intensive study in constructed ditches

- Modeling of ditch performance
- Microcosm study - pesticide behavior in plant / system fractions
- Model calibrated and refined for reproduction of observed hydraulic behavior, sedimentation, chemical trapping efficiency
- Conduct bioassessments to characterize biota & stressors of agricultural drains receiving runoff (already calibrated for California)

Project Framework

Phase 2:

Field test information gained during Phase 1

- Use model results to design “Optimum Ditch”
- Place demonstration ditches on variety of representative/important soil types
- Place ditches in fields with key crops: Tomato, alfalfa
- Conduct chemical & toxicological studies (water & sediment)
- Validate and refine model

Hydrograph

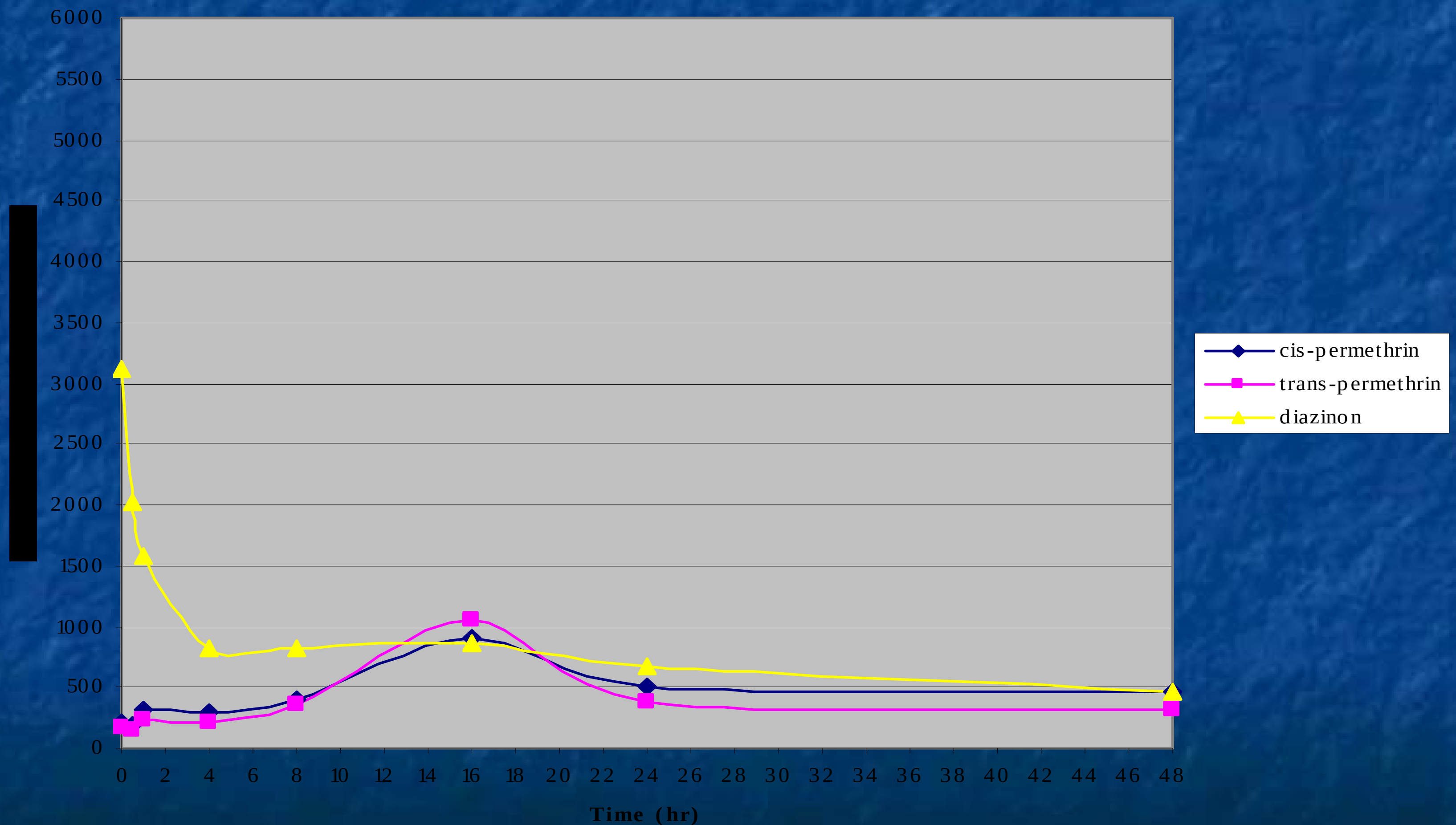
Irrigation events vary from 4 – 36 hr depending mainly on soil type and slope

On project site field, a repetitive event will typically:

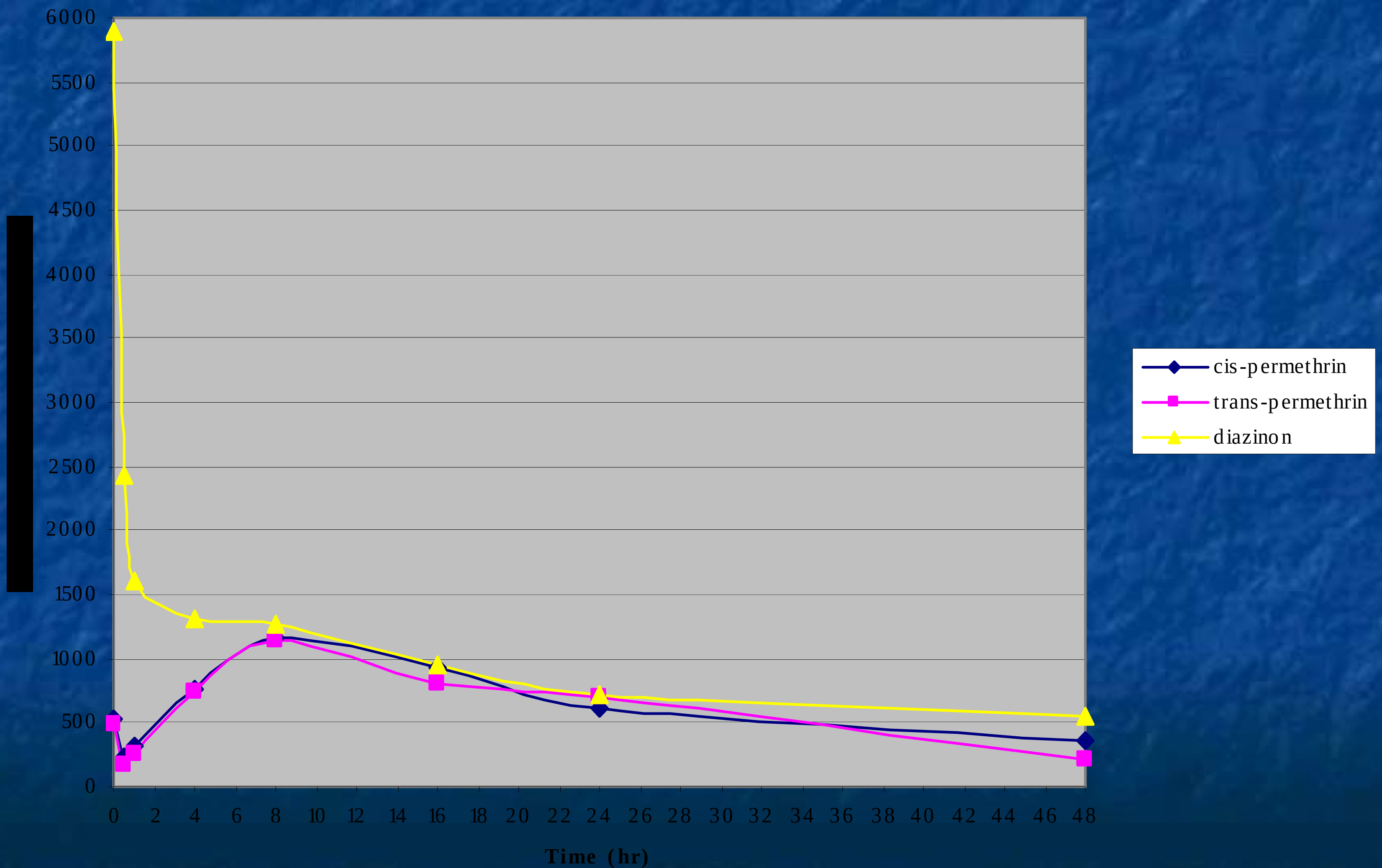
1. Have a 24 hr pump cycle
2. Have inflow of 900 gal / min (1.95 cfs)
3. Water begins draining off of field after 8 hr
4. Water ceases draining off ≤ 1 hr after pumping stops
5. Drainage ditch is typically dry at start
6. Estimated return to drainage canal flow is 10-15% or 0.2 – 0.3 cfs

Hydrograph

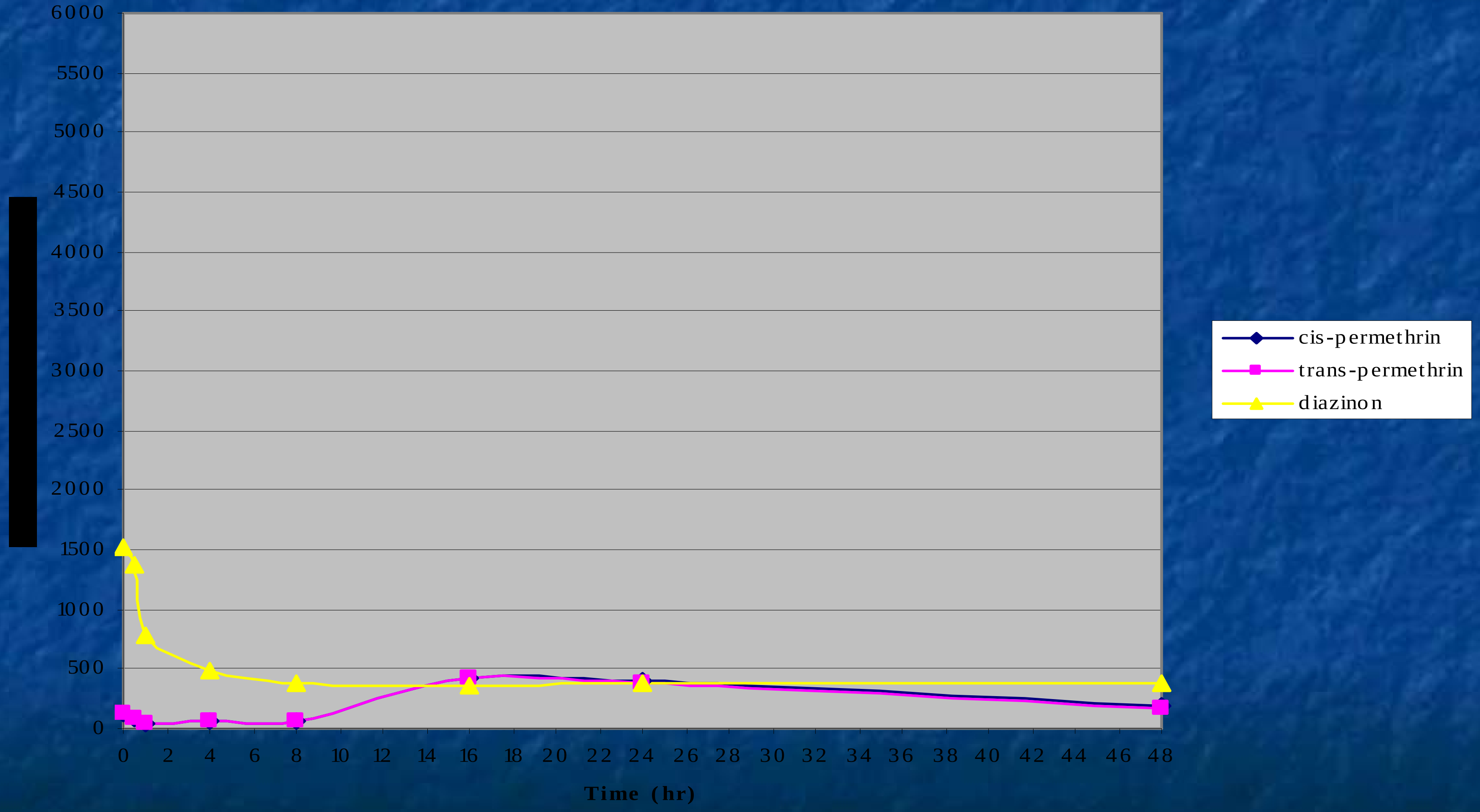
Results – U ditch



V ditch w/vegetation



V ditch non vegetation



Is this critical?

- Lee & Jones-Lee (2002):
  - Need for quantitative info on BMP efficiency for agricultural runoff and discharge
  - Lee & Jones-Lee (2002): Lack of available studies on BMP effectiveness in CA’s Central Valley

Is this critical?

USEPA (2002): "Twenty Needs Report"
(How research can enhance the TMDL process)

- 1. Improve watershed and water quality monitoring
- 2. Improve information on BMPs, restorations or other management practice effectiveness, and the related process of system recovery

Conclusions

- Ensure project success:
  - Building upon previous work from USDA
  - Diverse team of experts from agricultural landowners to toxicologists/chemists to modelers
  - External scientific advisory panel

- Project objectives:
  - On the ground practices that reduce pesticides along with sediment before entry into receiving waterbodies (proactive approach)
  - Products
    - USDA EQIP approved practices for farmers to readily implement
    - Hands on demonstrations with RCDs – technical transfer

The Future Grows Here
50
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Agricultural Research Service

Yolo County, CA

RCD

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